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Poliomyelitis—Cases reported by States.

State.	Period covered.	Cases reported.
Alabama	July 1 to Aug. 31	99
Arizona	July 1	1
Arkansas	July 1 to 31	5
California	do	12
Colorado	Jan. 1 to Aug. 17	4
Connecticut	July 2 to Sept. 9	583
District of Columbia	July 8 to Sept. 13	30
Delaware	Reported Aug. 22	5
Idaho	July 10 to Aug. 9	2
Illinois	July 1 to Sept. 10	495
Indiana	July 1 to Sept. 9	72
Iowa	July 1 to 31	30
Kansas	July 1 to Aug. 18	22
Louisiana	Jan. 1 to Aug. 31	59
Maine	Jan. 1 to Aug. 21	14
Maryland	July 1 to Sept. 14	110
Massachusetts	July 1 to 31	107
Michigan	July 1 to Aug. 31	214
Minnesota	Jan. 1 to Sept. 9	581
Mississippi	July 1 to 31	57
Montana	July 1 to Sept. 12	58
Nebraska	Reported July 11	2
New Jersey	July 1 to Sept. 14	3,230
New York (exclusive of New York City)	Jan. 1 to Sept. 9	2,592
Ohio	Jan. 1 to Aug. 15	166
Pennsylvania	July 1 to Aug. 11	273
Rhode Island	July 1 to 31	56
South Carolina	do	20
Tennessee	do	18
Texas	Jan. 1 to Aug. 10	30
Vermont	Aug. 1 to 31	8
Virginia	July 1 to Aug. 26	38
Washington	July 1 to 31	5
West Virginia	Aug. 1 to Sept. 9	15
Wisconsin	July 1 to Aug. 31	193

THE SEWAGE POLLUTION OF STREAMS.

ITS RELATION TO THE PUBLIC HEALTH.[1]

By W. H. FROST, Passed Assistant Surgeon, United States Public Health Service.

In every inhabited country the surface waters almost inevitably become more or less polluted with human excreta, but gross pollution of large streams, such as is now frequently encountered, results only where people are congregated in cities, discharging their wastes directly into watercourses through sewers, and these conditions are of comparatively recent development. This is especially the case in the United States, where many of the large cities have sprung up within a few decades; but even in the more densely populated European countries conditions of stream pollution have become much more serious within the last 50 to 100 years, with the development of sanitary sewerage.

A hundred years ago not even the great cities of Europe were provided with systematic and efficient sewerage systems for the removal of their wastes. They had sewers of some sort, but these were for the most part of erratic construction, designed more for surface drainage than for carrying away house wastes; and, indeed, the discharge of excreta into sewers was specifically prohibited, both in London and Paris, until the early part of the last century.

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[1] Presented before the section on hygiene and sanitary science of the Ohio State Medical Association, Cleveland, Ohio, May 17, 1916.

Modern sanitary sewerage systems with house connections for the removal of excreta and other domestic wastes are a comparatively recent development, the first movements toward systematic sanitary sewerage having been inaugurated about 1850. Since that time such rapid progress has been made in the sewerage of cities that now all the larger cities of this country have practically complete systems of sewers, with universal house connections; and though the smaller cities and villages are less completely sewered, public opinion is more and more insistently demanding adequate sewerage wherever people are assembled into communities.

The sum total of the benefits resulting from the provision of such sewerage systems for cities is indeed difficult, perhaps impossible, to estimate. Great as has been the effect of this improvement in the prevention of sewage-borne diseases, a just estimate of its influence is not to be based on this alone, but must take into account also the enormous social betterment resulting from the elimination of disgusting filth from the environment, the encouragement of more cleanly habits, and general elevation of ideals. Nevertheless, a direct consequence of this great sanitary achievement has been greatly to increase the pollution of watercourses; for the simplest and most obvious means of disposing of sewage is to discharge it directly into a convenient body of surface water, and this has been a common practice. Watercourses which previously were polluted with only such wastes as were thrown into them incidentally or washed in from the soil have now become much more grossly polluted by the discharge of fresh sewage from sewered communities.

In European countries the conditions resulting from the discharge of sewage into streams began to cause deep concern in the early period of development of sewerage systems, and during the last 75 years there has been a progressively increasing interest and activity in bettering such objectionable conditions and preventing their more serious consequences. The chief motive of this movement has always apparently been protection of the public health, as is evidenced in much of the legislation and especially by the fact that more or less authority in the control of stream pollution has commonly been vested in public-health authorities. In the early days of the movement the precise relations between stream pollution and public safety were, however, by no means clearly understood, and attention was very naturally directed first to the most offensive rather than the most truly serious conditions, the effort put forth being directed mostly toward the abatement of nuisances.

Very gross pollution of a stream with sewage gives rise to conditions so offensive as to constitute an obvious nuisance. Particles of fecal matter and other débris may be seen floating upon the surface of such a stream, the waters of which are more or less discolored; solids carried in the sewage are deposited upon the sides and bottom of the watercourse, forming offensive sludge banks; and, especially during warm weather, decomposition of organic matter in the sludge banks and in the stream gives rise to very foul odors. As is now known, these foul odors, which constitute the most offensive of the above conditions, are associated with and largely dependent upon exhaustion of the atmospheric oxygen which is found dissolved in all natural waters exposed to the air. The highly complex and unstable organic matter of fresh sewage is attacked by the bacteria and other organisms which, in converting this organic matter to their uses as food, bring about more or less profound changes in its composition. In the presence of an abundant supply of oxygen dissolved in the water, these changes are mostly in the direction of oxidation, and their end result is the formation of well-oxidized, stable, and inoffensive compounds, such as nitrates, carbon dioxide, etc., so that the stream gradually becomes "purified." If, however, the dissolved oxygen of the stream is used up by this process more rapidly than it can be replaced from the atmosphere, the organisms present in the water, while continuing to act upon the sewage organic matter, bring about a very different set of changes. Instead of being oxidized into stable and inoffensive compounds, this matter now undergoes a process of anærobic fermentation, familiarly known as putrefaction, being broken up into unoxidized, offensive, and foul-smelling substances.

In former days, when there was a widespread belief that epidemics of disease were caused by emanations of foul-smelling gases, the offensive conditions in a highly polluted stream were considered a gross menace to the health of persons in the immediate vicinity. Nowadays it is recognized that foul odors and disgusting appearances, while certainly not conducive to health or happiness, exercise at most an ill-defined, probably indirect, influence in the causation of disease; and while the necessity for abating such nuisance is universally recognized, it is for the sake of common decency rather than for the prevention of specific diseases.

For the prevention of the nuisance resulting from gross sewage pollution various processes of sewage treatment have been devised. These processes differ widely in their details, but all have two principal objects—the removal of solids and more or less complete oxidation of organic matter. The coarser solids may be removed by screening, finer solids by detention of the sewage in settling tanks, allowing sedimentation. In some instances the settling of solids is hastened and facilitated by chemical precipitation, and in most settling tanks the settled solids are more or less liquefied by septic action. In many cases the removal of solids by screening or sedimentation is sufficient to prevent nuisance from the discharge of sewage; but where the volume of the receiving body of water is small in proportion to that of the sewage which it receives, partial oxidation of the organic matter is often necessary to reduce the draft upon the oxygen supply of the watercourse, and thus prevent putrefactive changes. The process first applied, and still successfully used by some cities for such "purification" of sewage, is dispersion over large irrigation fields, where the sewage becomes purified by natural filtration through the soil. In this country such irrigation projects have generally been found impracticable, and sewage is more commonly treated by filtration, either through sand beds or, more commonly, through so-called trickling filters—beds of rather coarse broken stone upon which the sewage is sprinkled. In all these processes of sewage treatment, by percolation through soil, sand filters, or trickling filters, very rapid oxidation of organic matter takes place as the result of biological action, essentially similar to that which takes place in a stream in the presence of an abundant oxygen supply, but at a more rapid rate. The effluent from sewage thus treated is clear, comparatively inoffensive, and stable; that is, it will not putrefy, and may therefore be discharged into streams without causing nuisance.

Experience has proven that these processes of sewage treatment, with various combinations and modifications, are adequate for the prevention of the offensive nuisance resulting from excessive pollution of streams with raw sewage. The cost of such treatment, though considerable, is not prohibitive, and is being gradually reduced by further improvements in efficiency of methods.

Paradoxically, however, it is not these extreme conditions, giving rise to nuisance, which constitute the most serious and difficult problems of stream pollution. In the first place, the very offensiveness of a grossly polluted stream is so disgusting and has such direct economic effect in depreciating property values as to create an insistent popular demand for improvement of conditions. Quite commonly, too, the community responsible for the nuisance must itself suffer the consequences, and is therefore more ready to make the necessary expenditures for sewage treatment; and even if this is not the case, others suffering inconvenience thereby may usually, by recourse to the courts, compel the abatement of a nuisance which is obvious to all observers.

The prevention of grossly offensive nuisance is, however, only the minimum requirement, the first and the easiest step toward such control of stream pollution as will effectively safeguard the public health. The most serious consequences and the most difficult problems of control result from slighter pollution, not offensive, ordinarily not perceptible to the unaided senses. As is now thoroughly proven and generally understood, the most disastrous effect of stream pollution is the causation of more or less fatal infectious diseases among persons who drink the polluted waters. Distinctly offensive pollution is, in a sense, a protection against this danger, since water which is offensively polluted with sewage will not be so generally used for drinking and other domestic purposes; but water which is entirely inoffensive to the senses of sight, taste, and smell may still be dangerously contaminated with disease-producing organisms; and it is the use of such water that has been responsible for the enormous toll of human health and lives chargeable to the sewage pollution of watercourses.

The diseases which may be and frequently are caused by drinking sewage-polluted water include typhoid fever, Asiatic cholera, dysentery, and various more or less well-defined forms of enteritis, as well as infections with animal parasites. Each of these diseases is caused by a specific organism and, with the exception of certain animal parasite infections, the diseases of this group are peculiar to man, not affecting the lower animals. The specific germs of these infections have apparently no other natural breeding place than the human body, and are found in nature only in the bodies and the excreta of infected persons. Consequently, infection can take place only by ingestion of the excreta of persons previously infected. Human excreta are, therefore, the most dangerous as well as the most disgusting constituent of sewage, since there is always the likelihood that they may contain these specific disease germs.

Typhoid fever is, in this country, by far the most common and serious of the sewage-borne diseases, being so widely prevalent that practically no community of 10,000 people remains for a whole year free from this disease; and as a certain proportion of those who suffer from typhoid fever become chronic bacillus carriers, continuing for years to discharge typhoid bacilli in their excreta, it may be taken as an axiom that a water supply even slightly contaminated with the intestinal discharges of any considerable number of persons is certain at some time in the course of a year to contain typhoid bacilli and to cause more or less typhoid fever among its consumers.

It is therefore accepted as one of the rudimentary requisites for conservation of the public health that public water supplies must be protected from such dangerous contamination. This means not merely protection from offensive contamination, not merely providing water which is clean in the ordinary sense, but protection at all times, under all circumstances, against even the probability of slight pollution with disease germs. Many of our cities, however, especially the larger cities, are forced to take their water supplies from bodies of surface water subject to more or less sewage pollution, and are thus confronted by the problem of providing safe, clean water supplies from such polluted and dangerous sources. This problem may be approached from two directions—rigid prevention of the pollution of watercourses serving as sources of water supply, or efficient purification of all polluted water before it is distributed for use.

To completely protect a surface water supply from all danger of pollution with human excreta is a matter of more difficulty than is generally appreciated. Absolute protection can be guaranteed only by depopulation of the drainage area from which the water is collected, a measure obviously impracticable except on small watersheds, usually in a mountainous country and of small agricultural value. A considerable number of cities in the United States, notably New York and Boston, obtain their water supplies from protected watersheds either completely depopulated or thoroughly patroled to prevent contamination of the surface waters with human excreta. Even these cities, however, do not put their whole reliance in the efficiency of the measures taken to prevent pollution of their watersheds, but supplement this safeguard with more or less effective purification by long storage in impounding reservoirs. On a large, well-populated watershed, such as that of any considerable river, depopulation is, of course, out of the question. The first requisite for adequate protection of waters derived from such an area would be to divert from the drainage area or thoroughly purify the sewage from all sewered communities. The diversion of sewage is usually out of the question and the processes of sewage treatment which effectively prevent nuisance, though they reduce, by no means eliminate the danger of contamination with dangerous disease germs. Such purification of sewage as would render the effluent entirely harmless, though perhaps possible of achievement, could be accomplished only at a prohibitive cost; and even were this accomplished it would be still more difficult to enforce the measures necessary to prevent occasional slight but dangerous pollution from unsewered communities and country homes. The number of such sources to be controlled on a large, populous watershed is so great that to maintain adequate supervision over them amounts to an impossibility. Therefore, even with the most rigid supervision practicable, it would still be necessary to provide the additional safeguard of purification for water supplies taken from large streams; and, moreover, as most of our streams are more or less muddy, some treatment would be necessary to clarify their waters even though they were free from dangerous pollution.

Because of the manifold and obvious difficulties in the way of adequately safeguarding surface-water supplies by preventing their pollution, the sanitarians of the last 50 years, the period during which the importance of pure water supplies has been fully appreciated, have aimed, in the control of stream pollution, chiefly to prevent nuisance, rather than to eliminate all danger of sewage-borne infectious diseases; and for the protection of water supplies from polluted sources have devoted their energies and ingenuity to devising means for purifying water at a moderate cost. The efforts put forth in this direction have been so eminently successful that now, by the application of modern, scientific methods, including storage, sedimentation, precipitation, filtration, and disinfection by the use of hypochlorite of lime, liquid chlorine, and other disinfectants, it is possible, at a moderate cost, to procure satisfactory, clean, and safe water supplies from dirty and dangerously polluted sources. The development of the science of water purification, and the enormous general improvement in the quality of public water supplies resulting from the application of scientific methods constitute perhaps the most important of all the great advances in the field of municipal sanitation during the last 25 years.

The first effective filter to be put into use in the United States was installed at Poughkeepsie, N. Y., about 1875. The development of water purification in the United States since that time has been rapid, especially during the latter part of the period, as may be illustrated by some statistics cited by Mr. George A. Johnson, who estimates that in 1900 somewhat less than 2,000,000 people in the United States were supplied with filtered water, while in 1911 the population supplied was approximately 8,000,000,[1] and is at present about 20,000,000.[2] A further illustration is afforded by statistics collected by the United States Public Health Service, covering practically all public water supplies in the Ohio Basin,[3] which is a fairly representative section of the United States.

According to these records, which embrace the water supplies of about 6,300,000 people, 64.5 per cent of this population were, in 1915, using water from surface sources. About 9 per cent were using water taken from more or less fully protected watersheds, stored in impounding reservoirs; but in many instances the protection thus afforded was considered inadequate, and more than half of such supplies were further safeguarded by filtration, disinfection, or both. Approximately 3,500,000, or 55.5 per cent of the total population included in these records, are now taking their water supplies from rivers. Ninety per cent of these 3,500,000 people are supplied with water more or less effectively purified by sedimentation, filtration, disinfection, or combinations of these processes, only 10 per cent using unpurified river waters. Practically all the water-purification plants represented have been installed within the last 25 years, the majority within the last 10 years, during which period the three largest plants on the watershed, those of Cincinnati, Louisville, and Pittsburgh, have been put into operation.

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[1] Johnson, George A., The Purification of Public Water Supplies, Water-Supply Paper No. 315, U. S. Geological Survey, Washington, 1913.

[2] Johnson, George A., The Typhoid Toll, Jour. Am. Waterwks. Assn., Vol. III, No. 2, June, 1916, p. 252.

[3] Unpublished data collected by survey and from records furnished by State health authorities.

Some idea of what the purification of these water supplies has effected in the conservation of life and health may be afforded by the following illustrative figures, taken somewhat at random from those cities on the Ohio watershed which, since 1906, have taken their water supplies from streams and for which mortality statistics covering this period are readily available.

Eleven of these cities, with a total population of 243,000 in 1914, were still, in that year, taking their water supplies from the same sources as in 1906, with no purification. The average typhoid-fever death rate per 100,000 in these cities was, in 1906, 76.8, and in 1914 approximately the same, 74.5. Sixteen other cities, including Pittsburgh, Cincinnati, and Louisville, having in 1914 a population of 1,866,000, were in that year taking their water supplies from the same sources as in 1906, but with more or less effective purification. The average typhoid-fever death rate in these cities in 1906 was 90.5 per 100,000, and in 1914, 15.3.

Had these cities in 1914 suffered the same typhoid death rate as in 1906, they would have registered 1,688 deaths from this cause instead of the 286 deaths actually recorded. Thus in a single and not unusual year there was an indicated saving of 1,400 lives, due to the reduction in deaths from typhoid fever alone. There is good reason to believe that the saving in non-fatal cases of typhoid fever amounted probably to not less than 14,000 to 15,000.

Equally striking reductions in the prevalence of this disease have followed immediately upon purification of the water supply in scores of other cities with such regularity as to justify the opinion that in the cities cited the reduction in typhoid fever from 1906 to 1914 must be attributed in large part to improvement in their water supplies.

It is not to be inferred that there has been a proportionate reduction in typhoid prevalence among all the 3,150,000 people on the Ohio watershed now using purified river water. In some communities the water supply before purification was not so grossly polluted and was consequently not so large a factor in the causation of typhoid fever, hence its purification has been followed by a slighter reduction in the total prevalence of this disease. In other instances the water supplies have been inadequately purified and are still doubtless responsible for a considerable amount of typhoid fever. Where this is the case the fault, whether it lie in the construction or, as is more usual, in the operation of the purification plants, may in almost all cases be remedied at relatively slight additional cost; and it may be said that there are no insuperable obstacles to prevent all the 3,150,000 people using purified surface waters from having water supplies of as safe quality as those of the sixteen cities which have been cited in illustration.

To return to these cities, a point to be emphasized is that the improvement of their water supplies, with its consequent reduction in water-borne diseases, has been brought about almost wholly by *artificial purification*, not by radical improvements in their *sources of supply*. To be sure, such of these cities as were, in 1906, taking their water supplies from points below their own sewer outlets, have since removed their intakes upstream to avoid such immediate pollution. In general, however, the rivers from which these supplies are taken are more highly polluted now than ten years ago, owing to the growth of population, especially urban population, upon their watersheds.

In 1915 the urban population on the Ohio watershed amounted to 5,695,000, according to careful estimates. Of this, approximately 4,100,000, or 72 per cent, were sewered. During the decade from 1905 to 1915 the estimated increase in urban population was almost 29 per cent, and the percentage increase in sewered population was almost certainly greater. According to records compiled by the Public Health Service the sewage of about 457,000 people, or about 11 per cent of the sewered population on the watershed, was, in 1915, being treated in sewage-disposal plants, of which the majority have been constructed within the last decade. This progress in sewage treatment, though commendable, has very evidently not been sufficient to counterbalance the increase in sewage pollution due to growth of urban population and extension of sewerage. Considering that many of the smaller sewage-treatment plants on the watershed are inefficient, and that the better plants are not even designed completely to "purify" the sewage treated, it appears conservative to conclude that the sewage pollution of the Ohio River system is reduced not more than 5 per cent by the sewage-treatment plants now in operation, and that the net pollution from urban sewage is now nearly 25 per cent greater than it was 10 years ago.

In brief, during the last few decades the pollution of watercourses in the Ohio Basin, which is a fairly representative section of the United States, has been greatly increased by the growth of urban population and the extension of sewerage systems. To offset this increasing pollution, comparatively little progress has been made in the way of sewage purification, and what has been done has been almost exclusively for the prevention of nuisance. However, notwithstanding this increase in the pollution of streams which constitute the only available sources of water supply for 55 per cent of the urban population, the quality of public water supplies has, in general, been vastly improved, as the result of advances in the science of water purification and a more general application of modern methods.

This improvement in water supplies has resulted, in the Ohio Valley as elsewhere in the United States, in an enormous reduction in typhoid prevalence, and in the saving annually of thousands of lives. In other words, the most disastrous consequences of stream pollution have been largely prevented without improvement in the actual conditions of pollution.

Very evidently the maximum effects of water purification in minimizing the danger of stream pollution have not yet been attained. A small minority of the population of the Ohio watershed, as of other sections, are still using grossly unsafe, unpurified river water, but it is hardly to be imagined that the communities of which this is true will much longer endure the odium of such willful disregard of human life. A larger population are using water supplies more or less unsafe because of inadequate purification, but at the present rate of progress it may be confidently expected that the next few years will witness great improvements in these supplies, and on the whole the immediate future may be expected to show a continuation of the improvement in water supplies and the reduction in prevalence of water-borne diseases which have so distinguished the last few decades.

On the other hand, in the more or less distant future, there is imminent danger of a retrogression in quality of many water supplies with a recrudescence of water-borne diseases. The purification of a polluted water by even the most efficient of the methods applicable on a large scale is, after all, never perfect. A modern water-purification plant is a rather complex mechanism and its successful operation a matter of no little difficulty, requiring the constant supervision of a highly trained expert to adjust the mechanism of the plant to meet ever-changing conditions in the raw water. As in all such struggles of human ingenuity and diligence against the untiring forces of nature, lapses must occur. Increasing pollution of the water to be treated increases the difficulties of consistent adequate purification, increases the likelihood of occasional lapses, and magnifies the dangers of such lapses as do occur. With the rapid growth of urban population and development of sewerage the present tendency is toward an ever-increasing burden and responsibility upon the purification plants which safeguard the water supplies of millions. In the past this rapidly increasing pollution of sources of water supply has been successfully countered by even more rapid advances in efficiency and economy of water purification. Doubtless still further advances will be made in this direction, but probably not in such great strides as have already been made in the development, successively, of slow sand filtration, mechanical filtration, and disinfection processes. More likely the additional safeguard required will have to be provided, at least in part, by reducing the pollution of streams used as sources of water supply. The great present and future problem in the control of stream pollution is, therefore, to determine when, where, and how measures should be taken to limit or reduce the pollution of streams, not merely to prevent nuisance, nor on the other hand to prevent all dangerous contamination, but to avoid overburdening purification plants.

The difficulties of the situation are many. The cost of such sewage treatment as may be necessary materially to reduce the sewage pollution of large streams is the first difficulty. The community bearing an expenditure for sewage treatment to protect the water supplies of other communities does not itself receive the dividends from the investment in better protection of its own citizens' health; and for this reason such expenditures are likely to be opposed unless clearly demonstrated to be necessary. But obviously a dire necessity can be demonstrated in a specific instance only after conditions have already become so bad and continued so long as to have caused more or less extensive disaster; and this, of course, must not be permitted. The measures taken must be anticipatory and preventive, not remedial and delayed until after extensive injury has been done. They must therefore be in a sense arbitrary, sufficiently radical to maintain a wide margin of safety, and not so radical as to involve enormous expenditures without justification.

These principles appear to be quite generally accepted, but as to the details of their actual application there is as yet no general agreement, chiefly because of a lack of requisite information. This deficiency may be sufficiently illustrated by the mention of only two of the many important respects in which essential knowledge is lacking.

It is known, for example, that sewage discharged into a stream becomes "purified" by natural agencies, and it is recognized as economically wise to take legitimate advantage of this natural capacity of streams for sewage purification. As yet, however, there is almost no definite information as to the extent of this purification under given conditions and its consistency under the changing conditions brought about by seasonal variations in the physical and biological characteristics of streams. Without such information it is impossible to estimate accurately the effect which the sewage of one city will have in polluting the source of water supply of some other city downstream, and therefore impossible to estimate how far conditions at the lower city would be improved by any given treatment of the sewage from the upper city. Until sufficiently broad and careful studies shall have determined the fundamental natural laws governing stream purification, each instance will require an exhaustive and laborious special study, as at present.

Again, there is insufficient information as to the extent of danger from a moderately polluted water supply, such as the effluent from a slightly overburdened purification plant. The effect of a grossly polluted water supply in the causation of water-borne infectious diseases is readily demonstrable, because it has a predominant influence as the chief cause of such diseases in the community, but to distinguish the less striking effect of a slightly polluted water supply is a far more difficult matter, requiring more intensive studies than have yet been made. Yet even a very slight effect, if it exists, is serious, in view of the enormous population affected; and its demonstration is vital, as furnishing the evidence most essential to support arguments for more rigid protection of water supplies before they have become grossly polluted.

The first requisite in the control of stream pollution to-day is, therefore, a closer and broader study of the conditions of pollution existing in the rivers of the country, of the fundamental factors that influence these conditions, and, above all, of their effects upon health. Without such studies there can be no accurate knowledge as to the necessity for remedial measures and no reliable estimate of the influence of proposed measures in protecting the public health. In the meantime it is hardly to be expected that the public will be willing to invest enormous sums for the improvement of stream-pollution conditions without knowing what returns may be expected from their investment. It is not sufficient merely to state that there will be "some" returns in the saving of life and health; it is necessary to prove the assertion and, if possible, to show the extent of the saving in definite terms. The development of a universal sentiment in favor of water-purification plants must be credited chiefly to the definite proof of their efficiency in saving health and life. Similar proof will win equal approval for any further measures that may be required.

A great deal of diligent study has been and is being devoted to these problems, the existence and importance of which have long been recognized. As the need for further information becomes more urgent, these studies will naturally be intensified, and there need be no doubt that the problems will be solved and the difficulties overcome as successfully as other similar difficulties have been overcome in the past.